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Innovations and Human Capital of Business Owners: Evidence from SIBiL

Vyacheslav Dombrovsky
Stockholm School of Economics in Riga and
Baltic International Centre for Economic Policy Studies

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Financial Markets Group, London School of Economics and Political Science, LSE, UK
Dipartimento di Scienze Economiche e Finanziarie Prato, Università di Torino, TORINO, Italy
Centre for Financial Studies, CFS, Germany
Haute Etudes Commerciales, HEC, France
Baltic International Center for Economic Policy Studies, BICEPS, Latvia
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Indian School of Business, ISB, India
Tilburg University, UTIL.CER, Netherlands
University of Southern Switzerland, USI, Switzerland
The Institute of Physics, IBP, Serbia

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Vyacheslav Dombrovsky[1]

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Abstract

SIBiL stands for Survey of Innovative Businesses in Latvia, a unique dataset covering 1253 small firms. An important advantage of SIBiL is its compatibility with European Union's Community Innovations Surveys (CIS) and the section on the personal background of business owners. This paper uses this feature to examine the effects of the owners' human capital on innovations. There are four major findings. First, SIBiL finds substantially greater rates of product innovations as compared with CIS. Second, I find that the level of educational attainment has significant and robust positive effect on innovations. Third, this paper finds that the effect of higher education received after the Soviet era is substantially smaller. Fourth, I find no effects of owners' previous professional background on innovations.

[1] Stockholm School of Economics in Riga and Baltic International Centre for Economic Policy Studies, 4a Strelnieku St., Riga, LV1010, Latvia. Email: vdombrovsky@sseriga.edu.lv. The author gratefully acknowledges financial support from the European Commission as part of the Ricafe2 project (Contract CIT5-CT-2006-028942).

Non-Technical Summary

There is substantial literature that studies the determinants of the creation of new knowledge at the firm level. Much of this literature has focused on the role of R&D investment for the creation of new knowledge as well as the spillover effects that result from the public good nature of this knowledge. However, relatively few studies investigated the role of human capital in the production of innovations at the firm level.

This paper investigates the role of business owners' human capital for the innovative behavior of small firms in Latvia. There are two reasons that make this country an interesting case study for the effect of business owners' human capital on innovations. First, in spite of substantial progress in improving the business environment, it has done very poorly all the metrics of knowledge-based entrepreneurship. According to the World Bank's "Doing Business" 2009 report, Latvia's business environment is ranked 29th among 181 economies. However, according to the European Innovation Scoreboard 2008, Latvia is the second least innovative country in the EU (after Bulgaria), measured by the summary innovation index. Latvia has done much worse than Estonia, although both countries shared many similarities after the break-up of the Soviet Union. For example, Business R&D expenditure in Latvia is estimated at 0.21% of GDP, as compared with 0.54% of GDP in Estonia.[2] Second, the breakup of the Soviet Union and the ensuing transition from central planning to market economy implied substantial changes to the educational system. Soviet-era education was well reputed for its emphasis on hard science and engineering specialties. The economic transition, however, which was accompanied by collapse of many of the Soviet-era industrial giants, radically changed the payoffs to different fields of education.

There are two reasons why business owners' human capital may have an effect on the production of innovations. First, better educated individuals should be better placed to tap into the existing stock of knowledge, to learn from others and to produce new ideas. Second, Hellmann and Perotti (2006) suggest that presence of large firms may induce innovation when ex-employees of these firms will take their uncompleted ideas to the market.

This paper uses the Survey of Innovative Businesses in Latvia (SIBiL) to study the relationship between owner's human capital and firm level innovations. SIBiL is a novel micro-level dataset covering a wide range of innovative activities of 1251 small Latvian firms in 2007-2008. The sampling design of SIBiL is very similar to Community Innovation Survey (CIS), the main instrument for measuring firm-level innovations in the European Union. The questionnaire and the sampling method of SIBiL are nearly identical to those of the CIS. However, SIBiL has a number of important advantages. First, SIBiL complements CIS by focusing on small firms with less than 50 employees. In contrast, the CIS does not cover firms with less than 10 employees. Second, SIBiL is conducted using face-to-face interviews with owners and managers of the companies, which is a more reliable method compared with the mailed questionnaires used by CIS. All the interviews were conducted by *Latvian Facts*, a professional survey firm. Third, SIBiL has a substantially larger questionnaire, covering the areas of access to and the use of external financing, business strategy, and background of the owners, such as their human capital and prior professional experience. Fourth, SIBiL specifically focuses on sectors that EuroStat classifies as high-technology manufacturing and knowledge intensive services. About 35% of the

[2] European Innovation Scoreboard 2008.

firms in the sample operate in these sectors. Fifth, our survey data are merged with the financial and ownership data from the Business Registry.

The main findings of this paper can be summarized as follows. First, compared with the official estimates, the SIBiL shows substantial level of innovative activity, measured by product innovations or process innovations. Some 73% of all firms in the SIBiL sample reported having either product or process innovations that are new to the firm. In stark contrast, according to the Community Innovation Survey, the percentage of innovative firms in 2004-2006 was only 16.2%. Some of the discrepancy can probably be explained by focusing on small firms, high-technology sectors, and using face-to-face interviews, as opposed to mailed questionnaires used in the CIS. However, this finding raises questions on what is the more appropriate survey instrument for the measurement of self-reported innovations.

Second, this paper finds strong correlation between the level of educational attainment and the two measures of innovations used in this paper: product innovations and patent applications. Holding a bachelor's degree increases the likelihood of having product innovations by 9.5 percentage points as compared to having a secondary vocational degree, controlling for other factors. Holding a postgraduate degree increases the probability of product innovations by 18 percentage points. Formal education is especially important for patent applications. I find that holding a postgraduate degree increases the likelihood of patent application by 18 percentage points, compared to observationally equivalent business owner with secondary vocational education. As regards, the field of educational attainment, there is no statistical evidence that it is correlated with the measure of product innovation. However, having education in physics, chemistry, or natural sciences is found to be significantly and positively correlated with patent applications.

Third, this paper confirms that there are substantial differences in the level and field of educational attainment for business owners that received their higher education before and after the 1990. An average business owner is 47 years old and only 18% of all business owners could receive higher education after the Soviet era. Soviet-educated business owners were more likely to specialize in engineering, whereas post-Soviet educated business owners were more likely to specialize in business or entrepreneurship. Nearly all business owners with postgraduate education in the sample were educated in the Soviet times. Most importantly, this paper finds that post-Soviet education has much weaker effect on product innovations and patents. For example, there is no statistically significant difference in patent applications or product innovations between owners with vocational education and owners with master's degrees, controlling for other factors.

Fourth, this paper finds to evidence of former employees of large companies establishing innovative new ventures. Having an experience of being employed in a large firm, working as a knowledge worker, or having experience in the same industry has no significant effect on product innovations or patent applications. There are different possible interpretations of this finding. One explanation is that there are simply too few large firms that engage in large scale R&D activity in Latvia. Another explanation is that employees of these firms may find it difficult to start new knowledge-based ventures, possibly because lack of start-up financing.

1. Introduction

This paper investigates the role of business owners' human capital for the innovative behavior of small firms in Latvia. Specifically, it focuses on the effects of owner's formal education and previous work experience. This study adds to the substantial literature that studies the determinants of the creation of new knowledge at the firm level. Much of this literature has focused on the role of R&D investment for the creation of new knowledge as well as the spillover effects that result from the public good nature of this knowledge. However, relatively few studies investigated the role of human capital in the production of innovations at the firm level.

The focus of this paper is on Latvia, a post-communist economy in Eastern Europe. There are two reasons that make this country an interesting case study for the effect of business owners' human capital on innovations. First, in spite of substantial progress in improving the business environment, it has done very poorly all the metrics of knowledge-based entrepreneurship. According to the World Bank's "Doing Business" 2009 report, Latvia's business environment is ranked 29th among 181 economies. However, according to the European Innovation Scoreboard 2008, Latvia is the second least innovative country in the EU (after Bulgaria), measured by the summary innovation index. Latvia has done much worse than Estonia, although both countries shared many similarities after the break-up of the Soviet Union. For example, Business R&D expenditure in Latvia is estimated at 0.21% of GDP, as compared with 0.54% of GDP in Estonia.[3] Second, the breakup of the Soviet Union and the ensuing transition from central planning to market economy implied substantial changes to the educational system. Soviet-era education was well reputed for its emphasis on hard science and engineering specialties. The economic transition, however, which was accompanied by collapse of many of the Soviet-era industrial giants, radically changed the payoffs as perceived by the school graduates. Fields of education in engineering and sciences went into decline, while business and social science education became very popular. Moreover, the transition had the effect of impoverishing the

[3] European Innovation Scoreboard 2008.

universities, with widespread perception of degradation of the systems of higher education, especially in sciences.

There are two reasons why business owners' human capital may have an effect on the production of innovations. First, better educated individuals should be better placed to tap into the existing stock of knowledge, to learn from others and to produce new ideas. Second, Hellmann and Perotti (2006) suggest that presence of large firms may induce innovation when ex-employees of these firms will take their uncompleted ideas to the market. They argue that production of new ideas entails an important trade-off. On the one hand, elaborating an idea requires sharing it with various persons. A broad circulation of ideas is thus critical for the process of innovation. On the other hand, there is a fundamental problem with the open circulation of ideas, namely that information can be stolen. Established firms provide a safe idea exchange, serving as incubators for innovation. It is well known, for instance, that most R&D is performed in large established firms. In turn, markets complement firms by completing ideas that could not be elaborated inside firms. Firms incubate ideas, while markets increase their chances of elaboration. This complementarity suggests a natural *symbiosis* of large firms and markets.

This paper uses the Survey of Innovative Businesses in Latvia (SIBiL) to study the relationship between owner's human capital and firm level innovations. SIBiL is a novel micro-level dataset covering a wide range of innovative activities of 1251 small Latvian firms in 2007-2008. The sampling design of SIBiL is very similar to Community Innovation Survey (CIS), the main instrument for measuring firm-level innovations in the European Union. The questionnaire and the sampling method of SIBiL are nearly identical to those of the CIS. However, SIBiL has a number of important advantages. First, SIBiL complements CIS by focusing on small firms with less than 50 employees. In contrast, the CIS does not cover firms with less than 10 employees. Second, SIBiL is conducted using face-to-face interviews with owners and managers of the companies, which is a more reliable method compared with the mailed questionnaires used by CIS. All the interviews were conducted by *Latvian Facts*, a professional survey firm. Third, SIBiL has a substantially larger questionnaire, covering the areas of access to and the use of external financing, business strategy, and background of the owners, such as their human capital and prior professional experience. Fourth, SIBiL specifically focuses on sectors that EuroStat classifies as high-technology manufacturing and knowledge intensive services. About 35% of the firms in the sample operate in these sectors. Fifth, our survey data are merged with the financial and ownership data from the Business Registry. Summing up, SIBiL provides unprecedented wealth of data on the activities aimed at the production, use, and acquisition of knowledge within small firms. What makes our data unique is that it has detailed information on personal backgrounds of the owners of small firms. A substantial number of studies merged Community Innovation Surveys with the data on firms from Business Registries or other official sources. However, to the best of our knowledge, there is no study that tried to link CIS data to the personal background of owners.

The main findings of this paper can be summarized as follows. First, compared with the official estimates, the SIBiL shows substantial level of innovative activity, measured by product innovations or process innovations. Some 73% of all firms in the SIBiL sample reported having either product or process innovations that are new to the firm. In stark contrast, according to the Community Innovation Survey, the percentage of innovative firms in 2004-2006 was only 16.2%. Some of the discrepancy can probably be explained by focusing on small firms, high-technology sectors, and using face-to-face interviews, as opposed to mailed questionnaires used in the CIS. However, this finding raises questions on what is the more appropriate survey instrument for the measurement of self-reported innovations.

Second, I find strong correlation between the level of educational attainment and the two measures of innovations used in this paper: product innovations and patent applications. Holding a bachelor's degree increases the likelihood of having product innovations by 9.5 percentage points as compared to having a secondary vocational degree, controlling for other factors. Holding a postgraduate degree increases the probability of product innovations by 18 percentage points. Formal education is especially important for patent applications. I find that holding a postgraduate degree increases the likelihood of patent application by 18 percentage points, compared to observationally equivalent business owner with secondary vocational education. As regards, the field of educational attainment, there is no statistical evidence that it is correlated with the measure of product innovation. However, having education in physics, chemistry, or natural sciences is found to be significantly and positively correlated with patent applications.

Third, this paper confirms that there are substantial differences in the level and field of educational attainment for business owners that received their higher education before and after the 1990. An average business owner is 47 years old and only 18% of all business owners could receive higher education after the Soviet era. Soviet-educated business owners were more likely to specialize in engineering, whereas post-Soviet educated business owners were more likely to specialize in business or entrepreneurship. Nearly all business owners with postgraduate education in the sample were educated in the Soviet times. Most importantly, this paper finds that post-Soviet education has much weaker effect on product innovations and patents. For example, there is no statistically significant difference in patent applications or product innovations between owners with vocational education and owners with master's degrees, controlling for other factors.

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This paper is related to the following strands of literature. First, there is substantial literature, dating back to Griliches (1979), which models productivity growth as a function of physical inputs and knowledge inputs, e.g. R&D investment, or patents. More recently, an influential paper by Crepon, Duguet, and Mairesse (1998) introduced a framework, which entails estimation of a system of equations. First, firms decide whether to do R&D or not. Second, they decide on intensity of R&D. Intensity of R&D determines innovation output (patents, innovations). One of the novelties of Crepon, Duguet, and Mairesse was to use self-reported innovations from the early version of Community Innovation Surveys. There now a large literature that employs this framework to investigate the role of innovations (see Hall and Mairesse, 2006 for an overview of some of these studies). This paper is focuses on one stage of this framework – the production of innovations, as measured by product innovations and patents. The contribution to this literature is that this paper adds an additional measure of the stock of the firm's knowledge, namely the human capital of its owners.

Second, there is large literature that attempts to identify and measure knowledge spillovers. The literature on localized spillovers suggests that being geographically close to innovators matters (Audretsch and Feldman ,1996; Keller, 2002). Griffith, Harrison, and Van Reenen (2006) look at location of inventors within firms across geographical boundaries, specifically, at British firms putting their R&D labs to U.S. for technology sourcing. There is MNE spillover literature, which suggests that MNEs are a natural source of such knowledge flows. Javorcik (2004) is a prominent example here.

Third, there is the literature that looks at the human capital and personal background of innovators. Mostly papers in this literature look at the background of patent holders. For example, Mariani and Romanelli (2007) examine the background of 793 investors using PatVal-EU survey.

The rest of this paper is structured as follows. Section two presents described the SIBiL dataset, outlines the empirical methodology, and present summary statistics. Section three reports the empirical results. Section four concludes.

2. Data and Empirical Strategy

A. Survey of Innovative Businesses in Latvia

This section describes a novel dataset on innovative behavior of small firms in Latvia that is used in this study. It discusses the similarities and differences between the Survey of Innovative Firms in Latvia. SIBiL and major existing datasets, the sampling strategy, design of the questionnaire, and results of the first wave of the survey.

SIBiL combines elements of a number of leading firm level surveys with Business Registry data on 1,254 small Latvian firms, provided by *Lursoft LLC*. The survey part of SIBiL borrows from EuroStat's Community Innovation Surveys (CIS), Panel Study of Entrepreneurial Dynamics (PSED)[4], U.S. Federal Reserve Survey of Small Business Finance, and Djankov et al (2005) survey of entrepreneurs in Russia, Brazil, China, and India. The first wave of the survey was conducted in 2007-2008 by *Latvian Facts*, a premier market research firm, using face-to-face interviews. Then, the survey data were merged with the Business Registry data in 1996-2007.

SIBiL is highly similar to Community Innovation Surveys, which are used to measure innovations in OECD and EU countries (OECD 2005). It uses the same questionnaire as the 4th wave of CIS and covers the same industries. However, compared to the CIS, SIBiL has a number of important advantages. First, SIBiL relies on face-to-face interviews with owners-managers of

[4] PSED2, Wave B, Survey Research Center at the University of Michigan.

firms, as opposed to mailed questionnaires typically used by the CIS. Second, SIBiL's target population is small firms with less than 50 employees.[5] In contrast, CIS typically covers firms with more than 10 employees. Thus, SIBiL complements CIS by covering micro-firms with less than 10 employees. Third, SIBiL ensures there is a sufficient representation of firms in high-technology manufacturing and knowledge intensive services, as classified by the Eurostat. Using NACE Revision 1, these are manufacture of aerospace (35.3), computers (30), electronics and communications (32), pharmaceuticals (24.4), scientific instruments (33), post and telecommunications (64), computer and related activities (72), and research and development (73). Fourth, SIBiL goes at great length to ensure accurate measurement of firms' innovations activities. By using the data on owners from the Business Registry, we make sure that the interviews are conducted with owners-managers of the firms. In contrast, usually it is not known who is filling out the mailed questionnaires.[6] Also, an important drawback of mailed questionnaires is that they may not provide respondents with a good idea of what is a product innovation.[7] An advantage of SIBiL is that the interviewers were trained to help the respondents with specific examples of product and process innovations in the respondent's industry.

The sampling strategy is also similar to the Community Innovation Surveys. The target population consisted of active firms with less than 50 employees in 2006 as well as firms that were first registered in 2007.[8] The sampling frame is based on the Business Registry, which excludes entities that are not obliged to submit financial reports, such as self-employed, farmers' cooperatives, etc. The industries that are covered in the survey are in the first column of Table 1. The second column provides the NACE codes of these industries.

The target population is broken down into 40 strata, formed by industry classification and employment size, as in a typical CIS. Stratification will typically give results with smaller sampling errors than a non-stratified sample of the same size. The third and fourth columns of Table 1 show the number of firms in the target population in each stratum. For example, there are 1,926 firms with less than 10 employees in manufacturing of food, clothing, wood, paper, publishing and printing, corresponding to NACE codes 15-22. Further, initial samples are formed using simple random sampling with each stratum. Initial sample sizes are determined so

[5] The main reason for not covering larger firms is that it is prohibitively expensive to conduct face-to-face interviews with owners of medium and large businesses.
[6] Anecdotal evidence suggests that mailed questionnaires are often delegated to accountants, secretaries, or interns.
[7] CIS questionnaires typically contain a brief standard definition.
[8] At the time of allocating the initial sample financial data were only available for 2006.

as to ensure a reasonable final sample size allowing for non-response rates of 30-40%. Thus, the main rule is that the initial sample size is 104 firms in strata with micro-firms (less than 10 employees), and 66 firms in strata with small firms (10 to 49 employees). Two major exceptions are high-tech industries of "Post and telecommunications" (64) and "Computers and related activities" (72), where larger samples were drawn. Also, census is conducted in most high-tech strata where number of firms in the target population is rather small. For example, the number of micro-firms in "Manufacture of pharmaceuticals" (24.4) is only 19. Thus, all of these firms are included in the initial sample. In total, the size of initial sample is 2,754 firms.

Then, we used Business Registry to obtain the phone number and legal address of each firm in the initial sample. Also, we obtained the name and the last name of the owner and chair of the board of each firm. The market survey firm sought to interview a designated owner-manager for each firm in the initial sample. To boost the response rate, the first step was to send an official letter signed by the principal researcher at the Stockholm School of Economics in Riga, asking to participate in the survey. This was followed up by a phone call from the market research firm to arrange the date for the interview. The fieldwork began in September 2007 and 1,251 full interviews were completed by September 2008. The last two columns of Table 1 summarize the results of the survey in terms of the final sample sizes in each stratum. A major unexpected difficulty was that many firms, especially the smallest ones, could not be found at their official addresses. These difficulties are summarized in the last three columns of Table 2. The rate of contactable refers to the percentage of firms in the initial sample that could be located and contacted by the interviewers. On average, only 58% of the firms in the initial sample could be contacted. The contactable rate is the lowest for micro-firms – 54% of the initial sample. It ranged from 34% for micro-firms in "technical testing and analysis" (74.3) to 100% for small firms in "manufacture of pharmaceuticals" (24.4). However, the response rate was quite high among the firms that were contacted – on average, 86%. The response rates for different strata are summarized in the third, fourth, and fifth columns of Table 2. These range from 53% for small firms in "transport and storage" (60-63) to 100% for micro-firms in "manufacture of aerospace equipment" (35.3).

Finally, the survey data were merged with the financial and ownership data from the Business Registry. Specifically, SIBiL has data on the balance sheets and profit statements in 1996-2007, as well as ownership data for 2007.

B. Empirical strategy

This section discusses the empirical strategy, specific hypotheses tested in this paper, and the measurement issues. To examine correlation between firm innovations and owner's human capital, several variations of the following equation are estimated

(1) $I_{ijr} = \theta RD_{ijr} + \mu GlEng_{ijr} + \beta X_{ijr} + \alpha Ed_{ijr} + \gamma EdFld_{ijr} + \delta PrXp_{ijr}$

$+\mu_j + \mu_r + u_{ijr}$

I_{ijr} is a measure of production of innovations for firm *i* operating in industry *j* and region *r*. This paper uses two approaches to measure innovations. First, respondents were asked whether their firm introduced product innovations in the three year period in 2005-2007. Product innovations here are defined as new or significantly improved product or services that are novel to the firm, in accordance with the Oslo manual (OECD, 2005). The exact question is C1 in the Appendix. The definition of product innovations used in this paper is rather broad as it includes innovations that are not new to the market, i.e. imitations of competitors' products. Second, this paper uses an indicator variable whether the firm has applied for patents in the three year period in 2005-2007. These two measures complement each other. The main drawback of using self-reported product innovations is that the extent to which a product is significantly improved might be a matter of respondent's subjective interpretation, implying measurement error. Thus, the estimation results from using self-reported product innovation as a dependent variable must be interpreted with caution because the measurement error may correlate with a large set of owner level characteristics (Bertrand and Mullainathan, 2001). The advantage of using patent applications is that there is substantially less subjectivity in self-reporting these, and, hence smaller measurement error, as compared with the measure of product innovations. The drawback of patents data, however, is that not all innovations are patented, especially if the technology is of tacit nature (Keller, 2004).

RD_{ijr}, research and development, is a vector of two dummy variables measuring whether firm engaged in intramural R&D activities in 2005-2007, and whether it did so on a continuous (as opposed to occasional) basis.[9] Both dummies are constructed from the responses to questions C13 and C14 (Appendix). $GlEng_{ijr}$ is a vector of dummy variables measuring the extent of the firm's global engagement, which could result in knowledge spillovers, and therefore, more innovations (Criscuolo, Haskel, Slaughter, 2005). The following dummies are used. First, there is a dummy variable measuring whether a firm is an exporter, i.e. has less than 100% of its sales in Latvia. This variable is constructed from responses to question B4. Second, there are two dummy variables measuring whether a foreigner holds shares in the company and whether he is a majority shareholder. These dummies are constructed using information from the Business Registry. Third, there is a dummy variable measuring whether a firm is part of a multinational enterprise, with head office located outside Latvia. It is constructed from responses to questions B3 and B3a. Finally, X_{ijr} is a vector of other firm and owner specific covariates used as controls. These are firm's size, measured in number of employees in 2007, firm's age, log number of owners, gender and age of the largest owner. I also include industry and region fixed effects. Industry fixed effects are at the NACE two digit level, whereas region fixed effects are for five major regions.

Turning to proxies for owner's human capital, this paper focuses on the aspects of (i) educational attainment; (ii) field of education; and (iii) previous professional experience. First, Ed_{ijr} is a vector of dummy variables that capture formal education of the largest owner. These measure whether owner's highest level of educational attainment is secondary vocational education, secondary general or less, bachelor's degree, master's degree, or postgraduate (doctoral) degree. The dummy variables are constructed from responses to question F7 in the Appendix. Second, $EdFld_{ijr}$ is a vector of dummy variables that capture the field of owner's highest professional education. These measure whether the largest owner has education in engineering or technology, information technology, hard sciences (physics, chemistry, or natural sciences), construction or architecture, or soft sciences (e.g. social science, law, humanitarian sciences). The variables are constructed from responses to question F8. Third, $PrXp_{ijr}$ is a vector of dummy variables that capture owner's previous work experience, in which he was engaged for

[9] Although the respondents were asked to estimate R&D expenditure in 2006, only 252 firms answered this question. The main reason for such a substantial non-response was that most small firms did not designate a special budget for R&D activities, but bundled these with other expenditures. Question C22 specifically asked whether firms had such a budget. Only 129 firms reported having such a budget, whereas 759 firms reported bundling R&D expenditures together with other costs.

the longest time before his current business. The following variables are used. First, there is a dummy variable measuring whether the owner previously worked in the same industry, measured by NACE two digit code. This variable is constructed from responses to question F10 in the appendix. Second, there is a set of dummy variables measuring whether the owner previously owned a business, worked as a director, a specialist with higher or professional education, or a worker. These variables are constructed from responses to question F11. Finally, there is a dummy variable measuring whether the owner previously worked in a large company with more than 250 employees. This variable is constructed from responses to question F12.

This paper tests two sets of hypotheses. First, there is a question of importance of the level and field of formal education for the innovations. Generally, we expect that higher level of educational attainment make entrepreneurs more knowledgeable and productive and, therefore, should include the likelihood of innovations. Moreover high levels of formal education are likely to be a pre-requisite for successfully applying for patents. Thus, my hypothesis is that $\alpha > 0$. Most importantly, there is a question whether a structural break in the system of higher education that has occurred in the 1990 has had any effect on the production of innovations. To test this hypothesis, I estimate equation (1) separately for the subset of owners who received higher education after 1990.

The second set of hypotheses relates to previous professional experience of the owners. As suggested by Hellmann and Perotti, presence of innovating large firms may result in substantial knowledge spillovers as key workers of these firms may have incentives to pursue some of their innovative ideas in new ventures. This paper attempts to measure these spillovers by using proxies for whether owners previously worked as specialists in large firms in the same industries. Thus, my hypothesis is that $\delta > 0$.

Because the dependent variable in both cases is a dummy variable, I estimate the above equation using probit model, using heteroskedasticity-consistent robust standard errors.

C. First look at the data

This section reports summary statistics for the dependent variables, main variables of interest, and control variables. Summary statistics are reported in Table 3, Panels A and B.

After cleaning the data, there are 1253 observations in the dataset. On average, 52.8% of the firms in the sample report having introduced product innovation in 2005-2007. Further, 30% of the firms reported having introduced product innovations that are new to the market. Generally, some 73% of all firms reported having any product or process innovations. It should be noted that this figure substantially exceeds the estimates from Latvia's Community Innovation Survey. According to the Central Statistical Bureau, the percentage of surveyed firms that was active in the area of innovations in 2004-2006 was 16.2%. The discrepancy is too large to be explained by small differences in the sampling method, e.g. SIBiL's focus on high-technology sectors and small firms. This is illustrated in the last column of Table 4, which shows the percentage of firms in groups of industries. Although the percentage of innovating firms is the highest in high-tech industries such as "manufacture of scientific instruments" (82.7%), and "computers & related activities" (68.5%), it is also quite high in rather ordinary manufacturing sectors. For instance, 53.6% of all firms in the sample that operate in manufacturing of food, clothing, wood, paper, publishing and printing (NACE 15-22) reported having product innovations in the last three years. Thus, it is likely that this discrepancy is largely a result of conducting face-to-face interviews versus mailed questionnaires. These findings are consistent with substantial anecdotal evidence that mailed questionnaires are either often filled by people other than the owner-manager of the firm, and that the businesses report having no innovations so as to reduce the likelihood of increasing the burden of reporting for the statistical bureau.

Further, 5.6% of the firms reported having applied for patents. This is consistent with estimates from the other countries (see, for example, Crespi, Criscuolo, Haskel, and Slaughter, 2007 for the evidence in UK). There is substantial correlation between patenting and product innovations. 80% of the firms that reported having applied for patents also report product innovations, and 68% of patent applicants report product innovations that are new to the market. However, 50.9% of firms that did not apply for patents reported product innovations, and 27% reported having introduced product innovations that are new to the market. This finding is consistent with the notion that many innovations are not patented (Keller, 2004). The fifth and sixth columns of Table 4 show there is substantial variation in the number of patent applications across industries. Predictably, the highest percentage of firms with patent applications in my sample is in high-tech industries like "research and development" (18.8%), "manufacture of scientific instruments" (10.8%), and "computer & related activities" (10.3%).

Turning to the owners' personal backgrounds, the survey has information about three largest individual owners. Generally, 55% of the firms have one owner, and 26% of the firms reported having two owners. Most firms (90%) reported having three or less owners. This paper employs the data on the lrgest individual owner. One problem was that for 158 firms the largest owner was reported to be another company. When this is the case I use the data on the next largest individual owner. In some cases respondents did not know about the individual background of the largest owner. These observations were dropped from the dataset. Thus, for example, we have 1044 observation points on the largest individual owner's gender, 988 observations on her age, 990 observations on educational attainment, and 919 observation points on the field of education. The largest loss of observations is for the data on the largest owner's previous work experience. For example, with regard to the size of the firm where the owner was previously employed for the longest time, we have only 790 observations, implying that we have this information only for 63 percent of the sample.

An average business owner is a 47 years old. Interestingly, average age of the largest owner in SIBiL sample is at least four years higher compared with the age of an average business owner in Latvia.[10] The difference in age is largely driven by business owners in high-technology industries being older. For example, average age of largest business owners in "research and development" and "manufacturing of scientific instruments" is 52 and 51 years, respectively.

Only 16.7% of all owners are females. Moreover, firms with product innovations are less likely to have female owners, as compared with firms without innovations. The difference is statistically significant at 1% level of significance. Owners of firms with patent applications are also less likely to be females, but the difference is not statistically significant. Further, entrepreneurs with product innovations are 1.7 years younger compared with entrepreneurs without innovations. However, there is no significant difference in the age entrepreneurs who patent, and those who do not.

Most entrepreneurs appear to be well-educated. 54% of the owners report having a bachelor's degree, 16.6% have master's degree, and 4.3% report having post-graduate education. Only 4%

[10] The benchmark here is the Global Entrepreneurship Monitor (GEM) 2007 data, which estimate average age of business owner at 41 years old. However, GEM only surveys individuals who are no more than 64 years old. Implementing the same restriction for SIBiL sample yields average age of 45 years, implying a difference of four years. It should be noted, however, that the sample of business owners in GEM is rather small – 108 observations in 2007. Average age for business owners from the GEM 2008 sample is 37 years. This suggests that the difference between population mean age of business owners in Latvia and population mean age for business owners in the sectors surveyed in SIBiL might be substantially larger.

report basic or secondary general education. Moreover, simple differences in means indicate that education strongly matters for innovations. Entrepreneurs with product innovations are more likely to have master's degree or a post-graduate degree, and are less likely to have secondary vocational education. The importance of education is even more pronounced for patenting behavior. The share of master's and postgraduate degrees is significantly higher among patent applicants. An entrepreneur who applied for patent is almost four times more likely to hold a postgraduate degree, as compared with entrepreneur without patent application.

As regards field of education, 40% of all entrepreneurs appear to have education in the field of engineering or technology. The next most popular field of education is in business (13.2%). 7% of all entrepreneurs have education in the area of Information Technology (IT). 7.9% hold degrees in physics, chemistry, or natural sciences. Taken together, there appears to be little correlation between the field of education and indicators of innovative behavior. An important exception is patenting behavior, which is more widespread among businesses whose owners have education in physics, chemistry, or natural sciences. 17.7% of owners with patents have education in this field, as compared with 7% of the owners without patents.

The data also show marked differences in both the level and field of education between business owners who were older than 36 years at the time of the interview, and those who were younger. The former group, which I will refer to as "Soviet era business owners" is likely to have received higher education before 1990, i.e. in the Soviet era. The latter group, which I will refer to as "post-Soviet era business owners", could only receive their higher education in post-Soviet era. In terms of educational achievement, a much higher proportion of post-Soviet generation of business owners (26%) has master's degrees, as compared to Soviet-era business owners (14%). Another striking feature of the data is the lack of post-Soviet business owners with postgraduate education. There are 43 business owners with postgraduate education in my sample, but only one is less than 36 years old. There are also substantial differences in the field of education. A large proportion (45%) of Soviet-educated business owners have education in engineering and technology. In contrast, 40% of business owners who were educated after 1990 have education in business or entrepreneurship. Only 15% hold higher education in engineering or technology.

Most entrepreneurs have had substantial prior professional experience before starting their current business. Only 9.8% of the owners reported this being their first professional activity.

However, only 23.1% of the owners had their longest work experience in the same industry, as measured by two digit NACE code. A majority (59.1%) of owners with prior professional experience worked as specialist with higher education. 31.2% worked as directors but not owners. 5.6% reported previously owning other businesses. Further, about 46.6% of owners reported previously working in small businesses with less than 50 employees. On the other hand, 23.7% had professional background in large firms with more than 250 employees. Taken together, however, there are very few owners that could have started new ventures using ideas developed during their careers in large firms. Only 36 owners worked in a large firm that operated in the same industry as their current firm. Even smaller number – 20 owners – worked as specialists with higher education in large firms in the same industry. Moreover, simple univariate statistics do not point to substantial differences in innovative behavior between those with professional experience in the large firms and those without such experience. On the contrary, the proportion of owners with the background in a large firm is smaller among those with product innovations, with the difference being significant at the 10% level. However, entrepreneurs with patent application are significantly more likely to have had experience owning other businesses, as compared to entrepreneurs without patent applications.

Further, I find significant correlation between innovativeness and a firm's global engagement, which is consistent with the spillovers literature. About 30% of all firms in my sample are exporters. However, the proportion of exporters is significantly higher among firms with product innovations and patent applications. For example, 50.7% of firms with patent applications reported to be exporters. The direction of causality, of course, is not clear. On the one hand, spillover literature suggests that there might be "learning from exporting". On the other hand, a growing literature on the determinants of exports suggests that firms with higher productivity are more likely to export. Thus, innovativeness could also make firms more likely to export by increasing productivity.

Based on the Business Registry data, 13.7% of all firms have at least one foreign owner, and 10.5% have a majority foreign owner. Also, firms with foreign owners are also more likely to have product innovations and patents. However, it should be noted that the difference in means is strongly statistically significant only for product innovations. Further, 5.7% of all firms reported being part of a multinational group of enterprises (MNE) with the head office located outside Latvia. Multinationals are also substantially more likely to have both product innovations and patent applications. For example, a firm with patent applications is three times more likely to be a MNE, as compared with a firm without a patent application. The difference for product innovations is similar in magnitude.

Measuring R&D investment for small firms is tricky because most owners are unlikely to have a special budget for these expenditures. 85.4% of the respondents reported that their firm does not have a budget designated for R&D. Only 252 firms answered the question about R&D expenditure and only 70 firms reported it to be nonzero However, 40.8% of the firms report having performed R&D activities in 2005-2007, and 27.8% of the firms claim to have done so continuously. Taken together, this implies that most small firms are not able to accurately estimate R&D expenditure because it is bundled with other costs. As expected, there is strong correlation between R&D activities and innovative behavior. For example, 43.7% of firms with product innovations report performing R&D activities on a continuous basis, as compared with 10.2% of the firms without product innovations.

Turning to other firm-level characteristics, an average firm in the sample is 9.3 years old, employs 13.5 people, and had sales of 583 thousands LVL in 2007. Firms with product innovations appear to be larger in terms of employees, but not in terms of sales. However, size of the firms does not appear to be a factor for the patent applications.

3. Empirical Results

A. Baseline regressions

In this section I subject the above findings to a more rigorous analysis. In an explanatory regression, the model described above is estimated with firm-level characteristics, R&D proxies, and measures of global engagement only. Probit model with heteroskedasticity-consistent robust standard error is estimated using the whole sample. The estimation results are presented in Table 5. Regressions (1) to (4) are estimated with product innovations as a dependent variable, whereas regressions (5) to (8) have patent applications as dependent variable. For all regressions I report marginal effects evaluated at means for continuous variables and discrete change from 0 to 1 for dummy variables. Heteroskedasticity-consistent robust standard errors are reported for all regressions. Regression (1) is estimated with number of employees, its squared term, age of the firm, and log of number of owners. In line with previous studies I find a positive and significant coefficient on the first term of the size proxy and negative and significant coefficient for the quadratic term, implying that larger firms are more likely to introduce product innovations, but that the effect is diminishing with size. Age of the firm appears to have a negative and statistically significant effect on product innovations, implying that younger firms are more innovative. The coefficient estimate for log number of owners is positive and significant, which may reflect the effects of larger stock of knowledge. Regression (2) in Table 5 adds dummies that measure R&D activity. As expected, both coefficient estimated are positive, economically large, and statistically significant at 1% level. Further, regression (3) in Table 5 adds measures of global engagement. In line with the previous literature, I find substantial correlation between exporting and product innovation. Being an exporter increases the probability of introducing product innovation by 17 percentage points and the effect is highly statistically significant at 1% level. Interestingly, the coefficient estimates on the foreign owner and majority foreign owner dummies are not statistically significant. In contrast, the coefficient on being part of a multinational firm is positive, statistically significant, and large in economic sense. Of course, there is substantial correlation between being a multinational and having foreign owners, which may result in multicollinearity. However, estimating Regression (3) without the multinational dummy does not change significance of coefficient estimated on foreign ownership dummies. Finally, Regression (4) in Table 5 is estimated with industry and region fixed effects. Adding these controls does not result in substantial changes in the estimates of the effect of size, R&D activity, and foreign ownership. The coefficients on the number of owners and age of the firm decrease in magnitude and lose statistical significance, implying that younger firms with more owners are more likely to perform R&D activities and be globally engaged.

Regressions (5) to (8) in Table 5 replicate regressions (1) to (4), respectively, but with patent applications as a dependent variable. Interestingly, the coefficient estimates of firm-level characteristics like number of employees and its quadratic term, age of the firm, log number of employees are not statistically significant. Turning to the proxies for R&D activities, only continuous R&D has statistically significant coefficient estimate in regressions (6) and (7), but not in regression (8) with industry and region fixed effects. The most robust measure of global engagement is the exporter dummy, which is highly statistically significant in both regression (7) and (8). Moreover, the estimate is economically large, implying that exporters are 4.3 percentage points more likely to apply for patents. The multinational dummy is only weakly statistically significant in Regression (8) but the estimated coefficient is 0.092, which is a rather large effect. Note that adding industry and region fixed effects in Regression (8) results in substantial loss of observations. The reason is that the model cannot be estimated with full sample as within some industries and regions not applying (or applying) for patents is perfectly predicted.

B. Education

I proceed with investigating the effects of education on innovations. First, I focus on the role of educational attainment. Regression (1) in Table 6 reports the marginal effects from estimating a probit model with product innovation as a dependent variable and educational attainment dummies, gender, and age as explanatory variables. The omitted group for education dummies are owners with secondary vocational education. The coefficient estimate on female dummy is -0.12 and highly statistically significant. This means that a female is 12 percentage points less likely to introduce a product innovation, as compared to a male of the same age and level of education. The estimated effect is economically significant, given that 52.8% of firms in the sample report product innovations. The coefficient of age is negative and economically significant. What matters most for this paper, however, is that all education dummies are positive and highly statistically significant. Moreover, the coefficient estimates are economically large and consistent. Higher educational attainment is correlated with higher likelihood of product innovations. For example, a business owner with a bachelor's degree is 9.7 percentage points more likely to report product innovation compared with an owner with vocational education, controlling for other factors. An owner with postgraduate education is 22 percentage points more likely to report product innovation, compared with an owner with vocational education of the same age and gender. In Regression (2) I control for firm level characteristics, such as the number of employees with a squared term, age of the firm, log number of owners, as well as industry fixed effects, measured at NACE2 level, and regional fixed effects. However, I do not report coefficient estimates for the control variables. Inclusion of these controls does not change the magnitude of the education dummies but reduce the statistical significance of master's degree and postgraduate degree dummies. However, both dummies are still significant at 5% level. Also, the coefficients of female and age variables drop in absolute magnitude and decrease in statistical significance. Next, in regressions (3) and (4) I add controls for R&D activity and firm's global engagement, respectively. Estimation results for these control variables are suppressed. This results in the following changes in the main results. First, the coefficient estimates of postgraduate and master's degree dummies are decreased to 0.18 and 0.11, respectively. Second, these coefficients are now only statistically significant at 10% level. This suggests that better educated business owners are also more likely to perform R&D and be globally engaged.

Next, in regressions (5) to (8), I replicate the regressions (1) to (4), respectively, but with patent application as a dependent variable. Another major difference is that industry and region fixed effects are not used as these result in substantial loss of observations.[11] Again, coefficient estimates on all education dummies are positive, consistent, and significant in both economic and statistical sense in all the specifications. The coefficient estimates in Regression (8), for instance, suggest that business owners with a postgraduate degree are 18 percentage points more likely to apply for a patent, compared with owners with a secondary vocational education. This effect is very large in economic sense since only 5.6% of firms in the whole sample reported applying for a patent.

Taken together, the results in Table 6 provide strong evidence that the level of educational attainment of business owners matters to the production of innovations. Having a postgraduate degree increases the likelihood of introducing a product innovation by 18 percentage points, compared with an observationally equivalent business owner with a vocational degree. Moreover, I find that having advanced postgraduate education attainment has an especially large effect on applications for patents.

Next, this paper turns to the question whether field of education has any effect on the production of innovations. Regression (1) in Table 7 reports the marginal effects from estimating a probit model with product innovation as a dependent variable and field of education dummies as main variables of interest. The omitted group for field of education dummies are owners with education in business or entrepreneurship. The model also includes controls for level of education, gender, and age of the business owner. The only field of specialization dummy that has a positive and statistically significant (at 10% level) coefficient estimate is having education in information technologies. In Regression (2) I introduce controls for firm characteristics, as

[11] Re-estimating the models with industry and region fixed effects, however, does not result in substantial changes to the results.

well as industry and region fixed effects. In Regression (3) I also control for R&D activity and global engagement of the firm. Adding these controls results in the IT dummy becoming smaller in absolute magnitude and losing its statistical significance.

In Regressions (4) to (6) in Table 7 I replicate regressions (1) to (3) but with patent applications as a dependent variable and without the industry and region fixed effects. The dummy on having education in engineering or technology is positive and statistically significant at 10% level in Regression (6), but becomes insignificant after adding controls for R&D. The main finding, however, is that the dummy for education in hard sciences is statistically significant at 5% level in all specifications and economically large. Taken together, the results in Table 7 imply that the field of education does not matter for product innovations, but having education in hard sciences (chemistry, physics, or natural sciences) results in higher likelihood of applying for a patent. This is consistent with the hypothesis that advanced education in 'hard sciences' is important for producing patentable innovations.

Finally, I turn to investigating whether the effect of education received in post-Soviet times is different from Soviet-era education. The study focuses on educational attainment and on higher education. Thus, the above models are re-estimated using a sample of business owners who were less than 36 years old at the time of the interview. The results are presented in Table 8. Regressions (1) to (4) are probit models with product innovation as a dependent variable. Marginal effects for a discrete change in dummy variable from zero to one are reported for the education dummies. The dummy for postgraduate degree is dropped because there is only one business owner in the subsample with postgraduate education. Regression (1) controls for owner's characteristics such as age and gender. Regression (2) adds controls for firm characteristics, and Regression (3) adds controls for R&D and global engagement. Finally, Regression (4) also adds industry and region fixed effects, which results in substantial drop in the number of observations. Estimation results for all the control variables are suppressed. The main results are as follows. Coefficient estimates on all the education dummies are positive but not mutually consistent. For example, having a master's degree appears to have a smaller effect on the likelihood of product innovations than having a bachelor's degree. Only bachelor's degree dummy is statistically significant in Regressions (2), (3), and (4). The effect of having a bachelor's degree relative to having a vocational degree on innovations is substantially larger compared to estimates for the whole sample in Table 7.

Next, Regressions (5), (6), and (7) in Table 8 are estimated using patent application as a dependent variable. Regression (5) controls for owner's characteristics only. Regression (6) adds controls for firm characteristics, and Regression (7) adds controls for R&D and global engagement. Coefficients on bachelor's degree and secondary general education are positive and statistically significant at 10% level in Regression (7). Curiously, the coefficient on secondary general education dummy is extremely large. Taken together, the results in Table 8 suggest that Soviet and post-Soviet education have markedly different effects on the production of innovations, whether these are measured by product innovations or patents. Most strikingly, having more of post-Soviet education (e.g. a master's degree) does not necessarily mean a higher likelihood of innovations, as compared with having a secondary vocational degree. There is no evidence on the effects of post-graduate degrees because only one "post-Soviet" business owner in our sample has this degree.

C. Work Experience

Finally, this paper turns to investigating the effects of previous professional expeience on innovations. Regression (1) in Table 9 reports the marginal effects from estimating a probit model with product innovation as a dependent variable. The main variables of interest are dummies for previous work experience as a business owner, experience as a director, experience in the same industry, and experience working in a large firm. The omitted group is experience working as a specialist. Dummy variable for this being the first business activity is included but not reported. Owner's characteristics such as level of education, gender, and age are included but not reported. The main result is that neither of the proxies for owner's previous work experience is statistically significant. Moreover, dummy of work experience in a large firm has a negative coefficient. Then, Regression (2) adds controls for firm characteristics, industry and region fixed effects. Regression (3) adds controls for R&D and global engagement. Adding all these controls, however, does not change the main result.

Further, Regressions (4) to (6) in Table 9 replicate regressions (1) to (3) but with patent application being the dependent variable and excluding the industry and region fixed effects. Interestingly, the coefficient of experience being owner is positive and statistically significant in all three specifications, implying that business owners that applied for a patent owned a business in the past. The coefficient on having experience in the same industry is negative and small, not being statistically significant in any specification. The coefficient on working in a large firm is negative and statistically significant at 10% level in Regression (5).

In total, the results in Table 9 are not consistent with the hypothesis that there are substantial spillovers from the presence of large firms in the industry. Business owners with previous professional experience in large firms are not more likely to have product innovations or applied for patents. Moreover, having earlier work experience in the same industries does not contribute to innovativeness. As reported earlier, very few owners both worked in the same industry and in a large firm. However, one needs caution in generalizing these findings beyond Latvia. The findings may also indicate that there are too few large firms that are engaged in innovative activities, or that there are substantial obstacles to starting up innovative new ventures.

4. Conclusions

This paper examines the effect of business owners' human capital on product innovations and patent applications. It investigates several aspects of human capital: educational attainment, field of education, and professional experience. It also looks at the differences in the effects of higher education received in the Soviet times, as opposed to higher education obtained after 1990.

Using a unique firm level dataset on small firm in Latvia, this paper derives the main results. First, small businesses report levels of product innovations which are much higher than the estimates obtained with Community Innovation Surveys. This may suggest deficiencies in the survey instrument used by the national statistical bureaus, particularly mailed questionnaires. Second, the level of educational attainment has a significant and robust positive effect on both product innovations and patents. There is no evidence that field of educational specialization matters for product innovations. However, education in physics, chemistry, or natural sciences appears to be significantly correlated with patent applications. Third, education received after 1990 has a much weaker effect on product innovations and patents, as compared with education received in the 'Soviet-era'. This may be interpreted as a sign of degradation of the system of higher education after 1990. Fourth, I find no evidence that ex-employees of large firms start innovative new ventures. Previous professional experience of business owners has little effect on their innovative activity.

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Table 1: Sampling design

Sector	NACE	Target population		Initial sample size		Final sample size	
		<10	**10-49**	**<10**	**10-49**	**<10**	**10-49**
Mining and quarrying	10-14	37	38	37	38	17	11
Mfr of food, clothing, wood, paper, publishing and printing	15-22	1926	1354	104	66	52	45
Mfr of fuels, chemicals, plastics metals & minerals (except 24.4)	23-29	818	571	104	66	55	40
Mfr of pharmaceuticals	24.4	19	6	19	6	12	2
Mfr of office machinery and computer	30	35	13	35	13	16	9
Mfr of electrical machinery	31	54	24	54	24	29	11
Mfr of electronics and communications equipment	32	36	16	36	16	17	6
Mfr of scientific instruments	33	101	23	101	23	65	18
Mfr of transport equipment (except 35.3)	34-35	84	67	84	67	39	19
Mfr of aerospace equipment	35.3	3	2	3	2	2	1
Mfr not elsewhere classified	36-37	444	221	104	66	49	34
Electricity, gas and water supply	40-41	168	190	104	66	45	29
Wholesale trade	51	4797	2113	104	66	39	36
Transport & storage	60-63	2373	1199	104	66	52	13
Post & Telecommunications	64	219	68	219	68	71	33
Financial intermediation	65-67	418	101	104	68	42	21
Computer & related activities	72	833	137	155	137	80	67
Research and Development	73	82	13	82	13	43	8
Architectural & engineering activities	74.2	631	210	104	68	54	15
Technical testing and analysis	74.3	101	57	101	57	37	17

Notes: This table reports the sizes of the target population, initial sample, and the final sample. NACE classification refers to Revision 1. Each stratum is defined by industry and two classes by size of the firms: micro-firms with less than 10 employees, and small firms with 10 to 49 emlployees.

Table 2: Response rates by industries and firm sizes, percent

Industry	NACE	Response rate			Contactable rate		
		<10	10-49	total	<10	10-49	total
Mining and quarrying	10-14	90	100	94	57	79	63
Mfr of food, clothing, wood, paper, publishing and printing	15-22	92	94	93	49	74	59
Mfr of fuels, chemicals, plastics metals & minerals (except 24.4)	23-29	85	85	85	56	73	63
Mfr of pharmaceuticals	24.4	86	33	70	74	100	80
Mfr of office machinery and computer	30	80	77	79	57	100	69
Mfr of electrical machinery	31	88	92	89	62	71	64
Mfr of electronics and communications equipment	32	70	70	70	64	63	63
Mfr of scientific instruments	33	89	90	89	70	83	72
Mfr of transport equipment (except 35.3)	34-35	98	88	94	49	79	58
Mfr of aerospace equipment	35.3	100	50	75	67	100	80
Mfr not elsewhere classified	36-37	100	93	96	42	72	53
Electricity, gas and water supply	40-41	92	88	90	47	58	51
Wholesale trade	51	87	78	82	54	58	56
Transport & storage	60-63	91	53	78	52	43	49
Post & Telecommunications	64	91	85	88	54	76	62
Financial intermediation	65-67	72	76	74	52	62	55
Computer & related activities	72	80	81	81	61	66	63
Research and Development	73	87	91	88	57	85	60
Architectural & engineering activities	74.2	85	90	86	58	30	47
Technical testing and analysis	74.3	100	89	96	36	70	43
Total:		87	83	86	54	65	58

Notes: response rate is computed as a percentage of all contacted firms that resulted in completed interviews. Contactable rate is computed as percentage of firms in the initial sample that could be contacted by the survey vendor. NACE classification refers to Revision 1.

Table 3: Summary Statistics

Panel A						
	N	Whole sample	Product innovation		Patent application	
			yes	no	yes	no
Dummy for product innovation	1253	0.528	1	0	0.8***	0.509
Dummy for patent application	1242	0.056	0.086***	0.024	1	0
Owner's personal characteristics						
Dummy for female	1044	0.167	0.136***	0.203	0.095	0.172
Owner's age, years	988	46.8	45.99**	47.74	46.82	46.81
Owner's education						
Dummy for basic or secondary general education	990	0.043	0.039	0.048	0.032	0.044
Dummy for secondary professional or vocational education	990	0.208	0.18**	0.24	0.097**	0.215
Dummy for bachelor's degree	990	0.539	0.538	0.541	0.468	0.544
Dummy for master's degree	990	0.166	0.188**	0.14	0.258**	0.159
Dummy for postgraduate degree	990	0.043	0.055*	0.031	0.145***	0.037
Owner's field of education						
Dummy for technology or engineering	919	0.404	0.406	0.401	0.435	0.4
Dummy for information Technologies	919	0.07	0.082	0.055	0.097	0.068
Dummy for business or Entrepreneurship	919	0.132	0.122	0.143	0.065	0.137
Dummy for chemistry, physics, natural sciences	919	0.079	0.086	0.072	0.177***	0.071
Dummy for construction or architecture	919	0.058	0.044*	0.074	0.032	0.06
Dummy for social sciences, law, and other soft sciences	919	0.124	0.132	0.115	0.113	0.125
Dummy for other education	919	0.134	0.128	0.141	0.081	0.138

Notes: *, **, *** pertain to the two-sided t-test that the difference in means is zero and indicate significance at 10%, 5%, and 1% level, respectively.

Table 3: Summary Statistics (continued)

	Panel B					
	N	Whole sample	Product innovation		Patent application	
			yes	no	yes	no
Owner's prior professional experience						
Dummy for this business being owner's first activity	1030	0.098	0.106	0.089	0.082	0.1
Dummy for previous experience in the same industry	893	0.231	0.234	0.226	0.232	0.231
Dummy for previous experience owning a business	827	0.056	0.061	0.05	0.148***	0.048
Dummy for previous experience as a director	827	0.312	0.317	0.306	0.37	0.309
Dummy for previous experience as a specialist	827	0.594	0.591	0.597	0.481*	0.601
Dummy for previous experience as a worker	827	0.039	0.031	0.047	0	0.042
Dummy for previous experience in a company with more than 250 employees	790	0.237	0.213*	0.264	0.176	0.242
Firm's global engagement						
Dummy for being an exporter	1238	0.3	0.387***	0.205	0.507***	0.287
Dummy for having a foreign owner	1253	0.137	0.163***	0.108	0.2*	0.131
Dummy for foreign owner having a majority stake	1253	0.105	0.128***	0.078	0.157	0.098
Dummy for being part of multinational enterprise (MNE)	1244	0.057	0.084***	0.027	0.145***	0.049
Research and Development						
Dummy for performing intramural R&D	1234	0.408	0.567***	0.231	0.686***	0.389
Dummy for performing intramural R&D on a continuous basis	1216	0.278	0.437***	0.102	0.609***	0.258
R&D expenditure in 2006, thousands LVL	252	8.74	10.164	2.532	7.368	7.701
Firm characteristics						
Firm age in 2007, years	1229	9.278	9.066*	9.516	9.623	9.271
Number of employees in 2007	1206	13.534	15.893***	10.893	13.621	13.379
Log number of owners in 2007	1232	0.445	0.498***	0.384	0.426	0.448
Gross sales in 2007, thousands LVL	1095	583.363	606.41	556.634	465.721	587.939

Notes: *, **, *** pertain to the two-sided t-test that the difference in means is zero and indicate significance at 10%, 5%, and 1% level, respectively.

Table 4: Product innovations and patent applications by industries

NACE (rev.1)	Industry	All firms		Firms that applied for a patent		Firms with product innovation	
		Number of observations	Percentage out of total	Number of observations	Percentage within industry	Number of observations	Percentage within industry
10-14	Mining and quarrying	28	2.28	0	0.0	12	42.9
15-22	Mfr of food, clothing, wood, paper, publishing and printing	97	7.91	4	4.2	52	53.6
23-29 (except 24.4)	Mfr of fuels, chemicals, plastics metals & minerals	93	7.59	3	3.3	43	46.2
24.4, 30, 32, 35.3	Mfr of pharmaceuticals, office machinery, computers, electronics, communications and aerospace equipment [a]	64	5.22	4	6.3	41	64.1
31	Mfr of electrical machinery	39	3.18	0	0.0	20	51.3
33	Mfr of scientific instruments	75	6.12	8	10.8	62	82.7
34-35 (except 35.3)	Mfr of transport equipment	57	4.65	3	5.3	25	43.9
36-37	Mfr not elsewhere classified	80	6.53	4	5.1	39	48.8
40-41	Electricity, gas and water supply	72	5.87	1	1.4	21	29.2
51	Wholesale trade	79	6.44	4	5.1	39	49.4
60-63	Transport & storage	65	5.3	0	0.0	21	32.3
64	Post & Telecommunications	98	7.99	7	7.3	66	67.3
65-67	Financial intermediation	62	5.06	2	3.3	30	48.4
72	Computer & related activities	146	11.91	15	10.3	100	68.5
73	Research and Development	48	3.92	9	18.8	26	54.2
74.2	Architectural & engineering activities	70	5.71	3	4.3	25	35.7
74.3	Technical testing and analysis	53	4.32	2	3.8	27	50.9

Notes: [a] These high-technology sectors are merged into one group because separately each of them has a very small sample size.

Table 5: Determinants of product innovations and patents: baseline regressions

	Dependent variable: Product innovation				Dependent variable: Patent application			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of employees	0.0079***	0.0079***	0.0061***	0.0059***	0.00069	0.00036	0.00011	0.00020
	(0.00186)	(0.00192)	(0.00197)	(0.00212)	(0.000806)	(0.000745)	(0.000740)	(0.00118)
Employees squared	-0.000048***	-0.000052***	-0.000040**	-0.000034*	-0.0000058	-0.0000044	-0.0000034	-0.0000059
	(0.0000181)	(0.0000168)	(0.0000171)	(0.0000179)	(0.00000670)	(0.00000625)	(0.00000607)	(0.0000134)
Age of the firm	-0.0085**	-0.0078**	-0.0066*	-0.0050	0.0012	0.00095	0.00093	0.0014
	(0.00341)	(0.00366)	(0.00379)	(0.00404)	(0.00157)	(0.00149)	(0.00140)	(0.00187)
ln(Number of owners)	0.084***	0.064**	0.052*	0.042	-0.0014	-0.0061	-0.0048	-0.00059
	(0.0262)	(0.0287)	(0.0293)	(0.0300)	(0.0118)	(0.0106)	(0.0101)	(0.0129)
R&D activity		0.13***	0.13***	0.11**		0.0065	0.010	0.013
		(0.0457)	(0.0461)	(0.0513)		(0.0228)	(0.0216)	(0.0301)
Continuous R&D		0.33***	0.32***	0.32***		0.079***	0.055**	0.048
		(0.0444)	(0.0451)	(0.0485)		(0.0343)	(0.0297)	(0.0329)
Exporter			0.17***	0.19***			0.045***	0.043**
			(0.0343)	(0.0366)			(0.0159)	(0.0199)
Foreign owner			-0.049	-0.017			0.0034	0.036
			(0.0853)	(0.0897)			(0.0275)	(0.0455)
Majority foreign owner			-0.028	-0.058			-0.0065	-0.030
			(0.106)	(0.113)			(0.0312)	(0.0291)
Multinational			0.26***	0.28***			0.063	0.092*
			(0.0709)	(0.0689)			(0.0519)	(0.0707)
Industry and region fixed effects	N	N	N	Y	N	N	N	Y
N	1185	1145	1124	1109	1176	1136	1116	768
Pseudo R^2	0.023	0.131	0.154	0.198	0.003	0.059	0.086	0.114

Notes: This table reports marginal effects from probit regressions. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. Industry fixed effects are at the NACE 2 digit level. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

Table 6: Educational attainment, product innovations, and patents

	Dependent variable: product innovations				Dependent variable: patent application			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Secondary general or less	0.028	0.011	0.033	0.020	0.027	0.053	0.050	0.061
	(0.0845)	(0.0978)	(0.0984)	(0.102)	(0.0562)	(0.0698)	(0.0647)	(0.0717)
Bachelor's degree	0.097**	0.095**	0.096*	0.095*	0.038*	0.041*	0.035	0.045**
	(0.0414)	(0.0476)	(0.0503)	(0.0513)	(0.0217)	(0.0221)	(0.0211)	(0.0213)
Master's degree	0.15***	0.13**	0.14**	0.11*	0.093***	0.11***	0.084**	0.089**
	(0.0500)	(0.0579)	(0.0601)	(0.0630)	(0.0440)	(0.0480)	(0.0453)	(0.0523)
Postgraduate degree	0.22***	0.22**	0.19*	0.18*	0.23***	0.23***	0.16***	0.18***
	(0.0715)	(0.0829)	(0.0863)	(0.0875)	(0.0931)	(0.0993)	(0.0856)	(0.0947)
Female	-0.12***	-0.096*	-0.079	-0.073	-0.033*	-0.037*	-0.031*	-0.027
	(0.0437)	(0.0490)	(0.0524)	(0.0531)	(0.0160)	(0.0148)	(0.0147)	(0.0134)
Age	-0.0044***	-0.0031*	-0.0036*	-0.0034*	-0.00056	-0.00059	-0.00041	-0.000077
	(0.00148)	(0.00181)	(0.00188)	(0.00193)	(0.000656)	(0.000630)	(0.000607)	(0.000555)
Industry and region fixed effects	N	Y	Y	Y	N	N	N	N
Firm characteristics	N	Y	Y	Y	N	Y	Y	Y
R&D dummies	N	N	Y	Y	N	N	Y	Y
Global engagement dummies	N	N	N	Y	N	N	N	Y
N	950	897	870	860	946	908	881	871
Pseudo- R^2	0.021	0.110	0.186	0.200	0.044	0.055	0.102	0.127

Notes: This table reports marginal effects from the probit regressions. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. The omitted group is secondary vocational education. Industry fixed effects are at the NACE 2 digit level. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

Table 7: Field of education, product innovations, and patents

	Dependent variable: product innovation			Dependent variable: patent application		
	(1)	(2)	(3)	(4)	(5)	(6)
Engineering, technology	0.055	0.053	0.037	0.066*	0.048	0.042
	(0.0581)	(0.0640)	(0.0694)	(0.0382)	(0.0342)	(0.0302)
Information technologies	0.14*	0.063	0.087	0.088	0.053	0.043
	(0.0763)	(0.0894)	(0.0916)	(0.0719)	(0.0599)	(0.0532)
Hard sciences	0.078	0.013	-0.043	0.15**	0.14**	0.11**
	(0.0754)	(0.0842)	(0.0899)	(0.0859)	(0.0840)	(0.0764)
Construction and architecture	-0.049	0.038	0.049	0.040	0.030	0.0048
	(0.0905)	(0.0984)	(0.103)	(0.0690)	(0.0600)	(0.0493)
Other education	0.040	0.027	0.029	0.028	0.026	0.025
	(0.0692)	(0.0774)	(0.0840)	(0.0469)	(0.0447)	(0.0409)
Soft sciences	0.075	0.098	0.059	0.059	0.053	0.020
	(0.0650)	(0.0699)	(0.0770)	(0.0533)	(0.0503)	(0.0386)
Industry and region fixed effects	N	Y	Y	N	N	N
Owner's characteristics	Y	Y	Y	Y	Y	Y
Firm characteristics	N	Y	Y	N	Y	Y
R&D dummies	N	N	Y	N	N	Y
Global engagement dummies	N	N	Y	N	N	Y
N	879	833	797	876	845	809
pseudo R^2	0.026	0.110	0.202	0.064	0.081	0.149

Notes: This table reports marginal effects from the probit regressions. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. The omitted group is education in business/entrepreneurship. Industry fixed effects are at the NACE 2 digit level. Owner's characteristics include age, gender, and level of education. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

Table 8: Education of post-Soviet business owners, product innovations, and patents

	Dependent variable: product innovation				Dependent variable: patent appliction		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Secondary general or less	0.32*	0.30	0.24		0.10	0.29	0.25*
	(0.114)	(0.143)	(0.183)		(0.161)	(0.282)	(0.276)
Bachelor's degree	0.085	0.21*	0.25**	0.34*	0.0099	0.058	0.036*
	(0.101)	(0.116)	(0.120)	(0.168)	(0.0457)	(0.0418)	(0.0253)
Master's degree	0.064	0.15	0.054	0.13	-0.015	0.032	0.027
	(0.109)	(0.115)	(0.138)	(0.177)	(0.0481)	(0.0602)	(0.0497)
Industry and region FE	N	N	N	Y	N	N	N
Owner's characteristics	Y	Y	Y	Y	Y	Y	Y
Firm characteristics	N	Y	Y	Y	N	Y	Y
R&D dummies	N	N	Y	Y	N	N	Y
Global engagement dummies	N	N	Y	Y	N	N	Y
N	174	165	159	125	173	164	158
pseudo R^2	0.026	0.094	0.236	0.399	0.028	0.088	0.185

Notes: This table reports marginal effects from the probit regressions for owners less than 36 years old. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. The omitted group is previous experience as a specialist. A dummy for this business being the first professional activity is included in regressions (1) to (3). Owner's characteristics include age, gender. Firm characteristics include quadratic polynomial for number of employees, age of the firm, and ln(number of owners). Industry fixed effects are at the NACE 2 digit level. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

Table 9: Professional experience, product innovations, and patents

	Dependent variable: product innovation			Dependent variable: patent application		
	(1)	(2)	(3)	(4)	(5)	(6)
Experience as owner	0.034	-0.098	-0.18	0.099**	0.079**	0.070*
	(0.140)	(0.167)	(0.183)	(0.0553)	(0.0531)	(0.0509)
Experience as director	0.010	-0.069	-0.11	0.025	0.033*	0.022
	(0.120)	(0.139)	(0.157)	(0.0187)	(0.0199)	(0.0154)
Experience in the same industry	-0.00048	-0.012	-0.032	-0.012	-0.0092	-0.018
	(0.0443)	(0.0491)	(0.0537)	(0.0169)	(0.0167)	(0.0127)
Worked in a large firm	-0.075	-0.055	-0.018	-0.026	-0.027*	-0.014
	(0.0463)	(0.0530)	(0.0553)	(0.0153)	(0.0148)	(0.0129)
Industry and region FE	N	Y	Y	N	N	N
Owner's characteristics	Y	Y	Y	Y	Y	Y
Firm characteristics	N	Y	Y	N	Y	Y
R&D dummies	N	N	Y	N	N	Y
Global engagement dummies	N	N	Y	N	N	Y
N	709	667	640	706	678	651
pseudo R^2	0.034	0.121	0.219	0.100	0.109	0.197

Notes: This table reports marginal effects from the probit regressions. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. The omitted group is previous experience as a specialist. A dummy for this business being the first professional activity is included in regressions (1) to (3). Owner's characteristics include age, gender, and educational achievement. Firm characteristics include quadratic polynomial for number of employees, age of the firm, and ln(number of owners). Industry fixed effects are at the NACE 2 digit level. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

APPENDIX: Selected questions from the SIBiL questionnaire

B3. Is your enterprise part of an multinational enterprise group?

1. YES
2. NO

98. DON'T KNOW

99. NA

B3a In which country is the head office located?

____

B4. Over the last two to three years of operation, what percent of your sales was in

Country	**%**
1. Latvia	
2. Lithuania and Estonia	
3. other EU countries	
4. CIS member countries (i.e. Russia, Belarus, Ukraine, Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Uzbekistan, and Georgia)	
5. Other countries	

READ: The purpose of our survey-obtain information only on innovation or innovations for three years (2005-2006-2007). We begin with the innovations in products (goods and services). Here we define product innovation as an introduction of a new good or service or a significantly improved good or service. **The innovation (whether completely new or improved) must be novel to your enterprise, but it doesn't necessarily need to be new to your sector or market.** Thus, simple resale of new goods purchased from other enterprises and changes of a solely aesthetic nature here are not considered innovations. It doesn't matter, however whether the innovation was originally developed by your enterprise or by other enterprises.

C1. During the three years 2005 to 2007, did your enterprise introduce new or significantly improved goods or services?

1. YES
2. NO

During the three years 2005 to 2007, did your enterprise engage in the following innovation activities:

	Yes	**No**	**Don't know/NA**
C13 Intramural (in-house) R&D Research and development is creative work undertaken within your enterprise to increase the stock of knowledge and its use to develop new and improved products/services and processes (including software development).	1	2	9
C14 If yes, did your firm perform R&D during 2005 to 2007:			
Continuously?	1	2	9

C22. Research and development is creative work undertaken within your enterprise to increase the stock of knowledge and its use to devise new and improved products and process (including software development). Do you have a special budget for research and development activities?

1. Yes. A separate budget is designated
2. No. R&D costs are bundled with other costs
9. Don't know/NA

C23. Please estimate the amount of expenditure for each of the following four innovation activities in 2006.

	(Include personnel and related costs)	Expenditure in
a) Intramural (in-house) R&D *(Include capital expenditures on buildings and equipment specially for R&D)*	……………Ls	999999

C31. During the three years 2005 to 2007, did your enterprise:

	Yes	No	Don't know/NA
A Apply for a patent	1	2	9
B Register an industrial design	1	2	9
C Register a trademark	1	2	9
D Claim copyright	1	2	9

F4_1. Is OWNER [F2_1] female or male?

1. Male
2. Female
9. Don't know/NA

F5_1. How old is the OWNER [F2_1]?

AGE ________________________ 999. Don't know/ NA

F7_1. What is the highest level of education the OWNER [F2_1] has completed?

1. Basic education (8-9 years)
2. Vocational school
3. Secondary general (11-12 years)
4. Secondary professional / technical (college)
5. Higher professional education (Bachelor degree)
6. Higher academic education (Bachelor degree)
7. Higher professional education (Masters degree)
8. Higher academic education (Masters degree)
9. Postgraduate degree (Ph.D., doctor's, etc.)
10. Don't know/NA

F8_1. [If answer to F7_1 is 2 or 4-9] What is the field of the OWNER [F2_1]'s highest vocational (professional) education? IWER: Do not show the card, MARK APPROPRIATE.

1. Pedagogical education
2. Arts and humanitarian sciences
3. Social sciences
4. Communication
5. Information Technologies
6. Entrepreneurship
7. Law
8. Natural Sciences
9. Chemistry and physics
10. Engineering, technology
11. Construction and architecture
12. Agriculture
13. Health and social care
14. Personal Services (e.g. barber)
15. Transport
16. Military and police force
17. Other (specify)_______________

F10_1. Please tell me about the professional activity which the OWNER [F2_1] was engaged in for the longest time before this business. For which industry did he/she work? (Record and code an answer using the CODEFRAME in the end).

Industry: ___________________________________

F11_1. What was the OWNER [F2_1]'s position performing that activity? (SHOW CARD)

Self-employed/ Managing owner of a company	1
Director / Manager, but not owners/shareholder	2
Specialist with higher education	3
Specialist with professional/technical education	4
Employee without special education	5
Qualified worker (agriculture included)	6
Non-qualified worker (agriculture included)	7

F12_1. How large was the company for which OWNER [F2_1] worked for the longest time before this business?

1. <10 employees
2. 10-49 employees
3. 50-250 employees
4. >250 employees
9. Don't know/NA